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MATTERS RELATING TO REMOTE SENSING OF THE EARTH BY SATELLITES, INCLUDING, INTER ALIA, APPLICATIONS FOR DEVELOPING COUNTRIES

THE THEME FIXED FOR SPECIAL ATTENTION AT THE 1991 SESSION OF THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE

Application of space photography to the study and forecasting of mineral and biological resources

Union of Soviet Socialist Republics: working paper

Over the past decade, the Soviet Union has gained considerable experience in the use of space photography to study natural resources and the environment. Initially, the study of mineral and biological resources was confined to the location of diverse geological structures and of various types of forests and agricultural areas. Subsequently, research involving use of spacecraft began to focus on forecasting those resources, which is of paramount practical importance.

To a considerable extent, this can be explained by the fact that a large volume of high-quality space materials has been obtained, among which photographs from automatic satellites of the Cosmos series are of particular interest. Space photographs at a scale of approximately 1:1,000,000 are taken simultaneously in the three bands of the spectrum (0.5-0.6 μm, 0.6-0.7 μm and 0.7-0.85 μm), and also on colour and spectrozonal film. With the aid of large-format synthesizers, synthesized images at a scale of approximately 1:200,000 are made from original 18 x 18 cm negatives. The methods of synthesis which highlight the important features of the natural environment of a scene are selected. Photographs at a scale of approximately 1:200,000 are taken on panchromatic or spectrozonal film. Such photographs have a resolution of 5-6 m, and up to 3 m for high-contrast objects, which is unparalleled in world practice. The size of the original

negatives is 30 x 30 cm, which makes it possible to cover approximately 60 km of an area. The great advantage of this type of photography is its wide field of view and great detail. The negatives can be used to produce photographs at a scale of 1:50,000 to 1:20,000 without sacrificing quality. A method has been developed for printing colour photographs from spectrozonal negatives using light filters which make it possible to obtain near-natural colours. When necessary, corrected photographs and digital photomaps are prepared; such photographs and maps ensure a high degree of geometric accuracy of the image of a scene and its conformity to the cartographic projection. A wide selection of photomaps at scales ranging from 1:1,000,000 to 1:25,000 are produced in conformity with standard map sheets.

In the study of mineral resources, several areas for the application of remote-sensing methods in the forecasting and identification of different mineral deposits have been defined; such methods fall under the general concept of analysis of space data for the study of mineral deposits, which includes lineament metallogeny, the study of ring-shaped mineral deposits, the detection of photographic anomalies around mineral deposit sites, the use of photo-interpretation data in computer forecasting systems, the interpretation of photographic anomalies for the identification of potentially oil- and gas-bearing structures, and the use of remote-sensing data in prospecting for building materials and other common minerals.

Lineament metallogeny is based on the use of space photographs to detect lineaments corresponding to highly fissured areas which are particularly prone to penetration by ore-bearing solutions.

The study of ring-shaped mineral deposits is based on the interpretation of various kinds of ring structures which influence the distribution of ore deposits.

The detection of anomalies around the mineral deposit sites is based primarily on the use of data obtained from multi-band space surveys and their synthesis.

In prospecting for ore deposits, photo-interpretation data are being more widely used in computer forecasting systems, among which the Region system is particularly widespread.

In prospecting for oil and gas, data from space surveys are used primarily in the regional and exploratory stages. In addition to the detection of the general structural characteristics of a terrain, space photographs are used to detect anomalies associated with potentially oil- and gas-bearing areas.

The Soviet Union has acquired a great deal of experience in the detection of various kinds of building materials, peat and sapropel with the aid of data obtained from space photography. In forecasting, use is made of the coincidence of such minerals with specific types of quaternary deposits and associated forms of relief.

In the forecasting of mineral resources, specialized maps, which rely heavily on remote-sensing data have been developed; they include geological, geological and mineralogical and structural maps.

In the Soviet Union, the principal and most promising uses of remote sensing for the rational use of biological resources and their evolution, taking due account of the needs of forestry and agriculture, are forest and agricultural mapping.

In the thematic mapping of forest resources, various forms of airborne and space photography are used, depending on the tasks to be accomplished:

- Multi-band photography (3-6);
- Black-and-white photography;
- Colour photography;
- Synthesized images.

In the study and mapping of forest resources, space data are used:

1. In photo-interpretation;
2. In ground studies;
3. In photo-interpretation in the field;
4. In airborne observation;
5. In compiling maps;
6. In planning.

The contemporary method of mapping of forest resources using space and airborne photography is based on the photo-interpretation of forest surveys, which is rather advanced in the Soviet Union; the techniques employed make it possible to determine not only the types of stands of timber but also their fullness and age, that is, to assess directly the size of biological resources.

With a view to promoting agricultural production, airborne and space photography is also used rather successfully in the compilation of thematic maps which reflect the current state and dynamics of land, water and vegetation resources. Such maps contain quantitative categories for assessing the natural resources under consideration, the degree of man-made desertification of natural landscapes, and the rationality of existing methods of agricultural production. Of principal importance in this series of maps are those which depict the current state and dynamics of agricultural areas as a whole and those which indicate land use, land-improvement activities and the desertification of agricultural lands. In addition to these maps, for every branch of agricultural production - animal husbandry, dry-farming and irrigated agriculture - interrelated series of maps are compiled which illustrate the diverse aspects of the current state of land, vegetation and water resources and the means for their optimum use.

Multi-band photography makes it possible to detect vegetation affected by insect pests or infectious diseases and to distinguish growing vegetation from vegetation which has completed its growth cycle.

The study of agricultural water supply conditions focuses on the photographic study of the distribution of underground water indicators.

In order to improve the quality of observations, work is carried out not only with photographs but also with positive film and double negatives. At present, stable forms and rather precise methodological principles for the use of remote-sensing photographic data in the compilation of diverse thematic agricultural maps have been developed.

On the whole, it can be said that the provisional methods of processing and interpreting aerospace information for the solution of specific tasks have been confirmed in the course of the comprehensive study and mapping of natural resources.

That work, which is based on the use of aerospace photographic information, has opened up new possibilities for the study and rational use of natural resources and their protection and reproduction, the prospecting of minerals, and the global assessment and forecasting of environmental conditions.

The Soviet Union's achievements in the area of remote sensing for peaceful purposes has led to the development of mutually advantageous international co-operation.

The organizations of the Main Office of Geodesy and Cartography of the USSR have concluded a number of long-term agreements on the provision of space photographs with firms and organizations of countries of North, Central and South America and the Near and Middle East. They also provide photographs upon request to the United Nations, in particular to the Food and Agriculture Organization of the United Nations.

In order to ensure the most effective use of data obtained from space surveys, the organizations of the Main Office of Geodesy and Cartography of the USSR provide consultation services and train foreign specialists in methods of processing and interpreting space data on natural resources.